भारतीय मानक
Indian Standard

IS 17055 (Part 5) : 2018

मृदा-संचालन मशीनरी — सुरक्षा

भाग 5 हाइड्रोलिक एक्स्कवेटर के लिए आवश्यकताएँ

Earth-Moving Machinery — Safety

Part 5 Requirements for Hydraulic Excavators

ICS 53.100

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December 2018 **Price Group 5**

Material Handling Systems and Equipment Sectional Committee, MED 07

FOREWORD

This Indian Standard (Part 5) was adopted by the Bureau of Indian Standards after the draft finalized by Material Handling Systems and Equipment Sectional Committee had been approved by Mechanical Engineering Division Council .

This standard supersedes IS/ISO 20474-5 : 2008 'Earth moving machinery — Safety: Part 5 Requirements for hydraulic excavators'.

In the formulation of this standard, considerable assistance has been derived from the following Indian and International Standards:

ISO 20474-5 : 2017	Earth moving machinery — Safety — Part 5: Requirements for hydraulic excavators

This Indian Standard is published in several parts. The other parts in this series are:

IS 17055 (Part 1) : 2018	Earth-moving machinery — Safety: Part 1 General requirements
IS 17055 (Part 3) : 2018	Earth-moving machinery — Safety: Part 3 Requirements for loaders

The technical committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 6683	Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests
ISO 12117-2 : 2008	Earth-moving machinery — Laboratory tests and performance requirements for protective structures of excavators — Part 2: Roll-over protective structures (ROPS) for excavators of over 6 t. Amd 1 : 2016

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*).' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

EARTH-MOVING MACHINERY — SAFETY

PART 5 REQUIREMENTS FOR HYDRAULIC EXCAVATORS

1 SCOPE

1.1 This standard (Part 5) gives the safety requirements specific to hydraulic excavators as defined in IS/ISO 6165. It is intended to be used in conjunction with IS 17055 (Part 1), which specifies general safety requirements common to two or more earth-moving machine families. The specific requirements given in this document take precedence over the general requirements of IS 17055 (Part 1).

This standard deals with all significant hazards, hazardous situations and events relevant to the earth-moving machinery within its scope (*see* IS 17055 (Part 1) : 2018, Annex A) when used as intended or under conditions of misuse reasonably foreseeable by the manufacturer. It specifies the appropriate technical measures for eliminating or reducing risks arising from relevant hazards, hazardous situations or events during commissioning, operation and maintenance.

1.2 This standard is not applicable to machines manufactured before the date of its publication.

2 REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IS No./Other Publications	*Titles*
IS/ISO 3449 : 2005	Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements
IS/ISO 3471	Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements
IS/ISO 6165	Earth-moving machinery — Basic types — Identification and terms and definitions
IS 11252	Earth-moving machinery — Zones of comfort and reach for controls
ISO 6683	Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests
IS/ISO 7096	Earth-moving machinery — Laboratory evaluation of operator seat vibration
IS/ISO 7135	Earth-moving machinery — Hydraulic excavators — Terminology and commercial specifications
IS/ISO 7451	Earth-moving machinery — Volumetric ratings for hoe-type and grab-type buckets of hydraulic excavators and backhoe loaders
IS 12206	Earth-moving machinery — Loader and front loading excavator buckets — Volumetric ratings
IS/ISO 8643	Earth-moving machinery — Hydraulic excavator and backhoe loader lowering control device — Requirements and tests
IS/ISO 10262	Earth-moving machinery — Hydraulic excavators — Laboratory tests and performance requirements for operator protective guards
IS/ISO 10567	Earth-moving machinery — Hydraulic excavators — Lift capacity
IS/ISO 12117	Earth-moving machinery — Tip-over protection structure (TOPS) for compact excavators — Laboratory tests and performance requirements
ISO 12117-2 : 2008	Earth-moving machinery — Laboratory tests and performance requirements for protective structures of excavators — Part 2: Roll-over protective structures (ROPS) for excavators of over 6 t. Amd 1 : 2016
IS 17055 (Part 1) : 2018	Earth-moving machinery — Safety: Part 1 General requirements

3 TERMS AND DEFINITIONS

For the purposes of this document, the terms and definitions given in IS 17055 (Part 1), IS/ISO 6165, IS/ISO 7135, and the following shall apply.

3.1 Excavator Hydraulic Excavator — Self-propelled machine on crawlers, wheels or legs, having an upper structure normally capable of a 360° swing with mounted *equipment* (**3.3**), primarily designed for excavating with bucket, without moving the undercarriage during the work cycle.

NOTES

1 An excavator work cycle normally comprises excavating, elevating, swinging and the discharging of material.

2 An excavator can also be used for object or material handling/ transportation.

3 Unless specifically identified as a cable excavator, an excavator is commonly referred to as a hydraulic excavator.

4 *See* Annex B for illustrations.

3.1.1 *Compact Excavator* — Excavator (**3.1**) with an operating mass 6 000 kg or less.

NOTE — *See* Annex B for illustrations.

3.1.2 *Walking Excavator — Excavator* (**3.1**) with three or more supporting legs which can be articulated, telescopic or both and which can be fitted with wheels.

Note 1 to entry: *See* Annex B for an illustration.

3.2 Extra-Long Reach Equipment Application — Application of *hydraulic excavator* (**3.1**) equipped with extra-long reach equipment.

NOTES — Extra-long reach equipment application includes the following:

1 extra-long front equipment application consisting of an extra-long boom and an

extra-long arm with lighter duty bucket for extra wide working range purpose;

2 telescopic arm application;

3 telescopic arm with clamshell bucket application;

4 extra-long front equipment demolition application consisting of an extra-long boom (multi- booms), extra-long arm and demolition attachment.

3.3 Material Handling — If this is the only intended application, this clause shall apply.

moving of scrap and loose bulk material, for example, scrap iron, demolition debris and mulch

3.4 Material Handling Excavator — If this is the only intended application, this clause shall apply.

hydraulic excavator (**3.1**) purpose-built for material handling and typically equipped with an elevated (fixed or movable) operator station

3.5 Demolition Application — If this is the only intended application, this clause shall apply. demolishing by pushing or pulling, or fragmenting by crushing or shearing, buildings or other civil engineering structures and their component parts.

3.6 Swing — Rotation of the upper structure of an excavator in relation to a fixed reference frame on the ground.

3.7 Working Swing Revolution Speed — Turntable-swing speed, reached in a 180° revolution of the upper structure with maximum rotation command input starting from a still position.

NOTE — It is expressed in revolutions per minute (r/m).

3.8 Deceleration Swing Angle — Angle measured in degrees of swing while the swing motion is decelerated from working swing revolution speed to a complete stop (halt).

3.9 Swing Torque — Torque which propels the upper structure relative to the undercarriage.

NOTE — It is expressed in newton metres (N·m).

3.10 Swing Service Brake — Device or system to decelerate the rotation of the upper structure and to bring it to a stop in any position.

EXAMPLE: Frictional brake, electrically operated brake, hydrostatically or other hydraulically operated brake (*see* Annex A).

3.11 Swing Parking Brake — Device or system to hold the stopped upper structure in a stationary position (*see* Annex A).

3.12 Swing Lock — Mechanically engaged device designed to block the upper structure in a fixed position with respect to the undercarriage (*see* Annex A).

4 SAFETY REQUIREMENTS AND PROTECTIVE MEASURES

4.1 General

Hydraulic excavators shall comply with the safety requirements and protective measures of IS 17055 (Part 1), in as far as those are not modified by the specific requirements of this clause.

Additional requirements shall apply if the optional feature is provided by the manufacturer.

4.2 Operator Station

4.2.1 *Operator Protection*

4.2.1.1 *Operator protective guard*

Excavators with an operating mass greater than 1 500 kg shall be designed so that an operator protective guard can be fitted. The manufacturer, according to the intended use of the machine, shall offer a protective guard. The protective guard shall be in accordance with IS/ISO 10262.

NOTE — For excavators used in demolition applications, additional requirements exist.

4.2.1.2 *Roll-over protective structures (ROPS) and tip-over protective structures (TOPS)*

ROPS/TOPS to be provided based on the specific regulatory/customer requirements.

4.2.1.2.1 *General*

Except for walking excavators (*see* **4.6.3**), IS 17055 (Part 1) : 2018, **4.3.3** does not apply.

Hydraulic excavators with an operating mass of 1 000 kg up to 6 000 kg shall be equipped with a TOPS in accordance with IS/ISO 12117. If the structure is compliant with the performance requirements given in both IS/ISO 12117 (TOPS) and ISO 12117-2 (ROPS), the manufacturer may identify both standards (TOPS and ROPS) on the label.

Hydraulic excavators with an operating mass greater than 6 000 kg and less than 50 000 kg shall be provided with a ROPS in accordance with ISO 12117-2.

Material-handling excavators with fixed cab risers and with an operating mass greater than 1 000 kg and less than 50 000 kg shall be fitted with a TOPS.

For evaluation of the performance of the TOPS, ISO 12117-2 shall be used in respect of lateral loading only and with the following lateral load energy, U_s:

$$U_s = 6{,}500 \times (M/10\,000)^{1{,}25}$$

The TOPS shall be labelled in accordance with ISO 12117-2 : 2008, **9**, as amended by ISO 12117-2 : 2008/Amd 1 : 2016, except that the reference shall be made to IS 17055 (Part 5) : 2018.

Alternatively, in fulfilling this requirement a manufacturer may provide a ROPS in accordance with ISO 12117-2. In such cases, the labelling may either be in accordance with ISO 12117-2 for ROPS or modified as specified above for TOPS. Where a structure complies with both ROPS and TOPS performance requirements, a manufacturer may optionally identify both standards (ROPS and TOPS) on the label.

NOTE — IS/ISO 12117 is intended to be applied to compact excavators having a swing type boom and an operating mass of between 1 000 kg and 6 000 kg. This does not preclude the possibility of establishing a reproducible means of evaluating the load-carrying characteristics of TOPS under static loading, and prescription of performance requirements of a representative specimen under such loading for excavators with an operating mass over 6 000 kg. In this case, the test is carried out in accordance with ISO 12117-2.

4.2.1.3 *Operator's seat*

If a suspension seat is provided for excavators, the seat shall comply with spectral class EM 6 as given in IS/ISO 7096:2008.

4.2.2 *Rear Window Defrosting System*

IS 17055 (Part 1) : 2018, **4.3.2.7**, shall only apply for rear window defrosting if visibility through the rear window is required according to IS 17055 (Part 1), **4.8.1**.

4.3 Controls for Driving and Steering

IS 17055 (Part 1) : 2018, **4.5.1** and **4.6.1** shall apply with the following addition/exception: the movements of the controls for driving and steering do not need to correspond to the intended direction of movement if the upper structure is not in the normal driving direction.

4.4 Swing Brakes

Swing brakes shall comply with the requirements given in Annex A.

NOTE — Requirements can differ for excavators with extra-long reach equipment.

4.5 Stability and Safety Devices

4.5.1 *General*

IS 17055 (Part 1) : 2018, **4.11** shall apply with the additions given in **4.5.2** to **4.5.4** below.

NOTE — All rated capacities as defined hereafter are based on tests, calculations, or both, of machines on a level and firm supporting surface.

The mass of the load, its density and the location of its centre of gravity, as well as the mass of the attachment and the quick coupler, if fitted, shall be included in the determination of the rated operating load and the size/capacity of the attachment.

In order to provide sufficient stability, the rated operating load in intended operations shall be determined as specified in **4.5.2** and **4.5.3**.

4.5.2 *Bucket and Shovel Applications*

The rated lift capacity of an excavator used in a bucket or shovel application shall be determined according to IS/ISO 10567.

The volumetric rating of the Hoe bucket or shovel bucket shall be determined according to IS/ISO 7451 or ISO 7546 or IS 12206.

4.5.3 *Object-handling Applications*

4.5.3.1 *General*

The capacity of excavators shall be determined in accordance with **4.5.3.2** and **4.5.3.3**.

4.5.3.2 *Rated lift capacity in object handling*

The rated lift capacity in object handling shall be defined by its rated lift capacity according to IS/ISO 10567.

4.5.3.3 *Rated lift capacity table in object handling*

A table of the rated lift capacity in object handling, established by the manufacturer, shall be provided in accordance with IS/ISO 10567. The tables shall be available at the operator's station for each object-handling configuration specified in the operator's manual.

4.5.3.4 *Load safety devices*

Excavators used in object-handling operations with a maximum rated lift capacity of ≥ 1 000 kg, according to IS/ISO 10567 or an overturning moment of ≥ 40 000 N·m shall have provisions for the following.

a) An acoustic or visual warning device which indicates to the operator when the rated lift capacity/corresponding load moment is reached and continues as long as the lift capacity or load moment is exceeded. The rated lift capacity is defined in **4.5.3.2**.

   This device may be deactivated while the excavator is performing operations other than object handling. The activation shall be clearly indicated. The control device for activation and deactivation shall be within the operator's zone of comfort according to IS 11252. A warning sign shall be placed close to the control device indicating the need for activation during object handling.

b) A lowering control device on each raising boom and arm cylinder to prevent uncontrolled movement in the case of a hydraulic line failure or rupture. For each arm cylinder the device shall be installed at the end which is pressurized to raise the arm away from the base machine. The lowering control device for each boom and arm cylinder shall be tested in accordance with IS/ISO 8643.

4.5.3.5 *Other applications*

The rated lift capacity of material-handling excavators and derivative machinery shall be determined by the manufacturer according to the load specification given in **4.5.3.2** and **4.5.3.3** and considering the comparable hazard.

4.6 Specific Requirements for Walking Excavators

4.6.1 *Operator Station*

4.6.1.1 *Steering system*

IS 17055 (Part 1) : 2018, **4.6.1**, is not applicable.

4.6.1.2 *Visibility*

IS 17055 (Part 1) : 2018, **4.8.1**, is not applicable.

The ground contacting part of each leg in all possible positions shall be visible from the operator's station in order to ensure that the operator can place the legs on firm ground.

4.6.2 *Wheel Brake System*

IS 17055 (Part 1) : 2018, **4.7**, is not applicable to walking excavators having a maximum of two wheels.

4.6.3 *Operator Protection*

4.6.3.1 *Roll-over protective structures (ROPS)*

Walking excavators shall be fitted with ROPS in accordance with IS/ISO 3471, as applicable in that International Standard to backhoe loaders of equivalent mass.

4.6.3.2 *Restraint systems*

All walking excavators fitted with a cab shall be equipped with an operator restraint system in accordance with ISO 6683.

4.6.3.3 *Falling-object protective structure (FOPS)*

Walking excavators shall be designed so that a FOPS in accordance with IS/ISO 3449 : 2005, level II, can be fitted (*see* also IS 17055 (Part 1) : 2018, **4.3.4**).

4.6.3.4 *Legs, hydraulic circuit*

All leg cylinders shall be fitted with lock valves to prevent the machine from becoming unstable in the case of a hydraulic system failure.

4.6.4 *Stability*

4.6.4.1 *Test conditions*

The stability shall be determined under the following test conditions:

a) on a level and firm supporting test surface;
b) with stabilizer and wheels (at maximum spread position) extended as specified by the manufacturer;
c) with the lower side of the undercarriage at a levelled position of approximately 350 mm above the test surface;
d) with tipping lines as shown in Fig. 1; and
e) at maximum reach with/without telescopic arm to the front/rear, as shown in Fig. 2,and to the side as shown in Fig. 3.

4.6.4.2 *Bucket applications*

The capacity of walking excavator in bucket applications shall be determined according to IS/ISO 10567.

The volumetric rating of the bucket shall be determined in accordance with IS/ISO 7451.

4.6.4.3 *Object-handling applications*

The rated lift capacity in object handling shall be determined according to IS/ISO 10567.

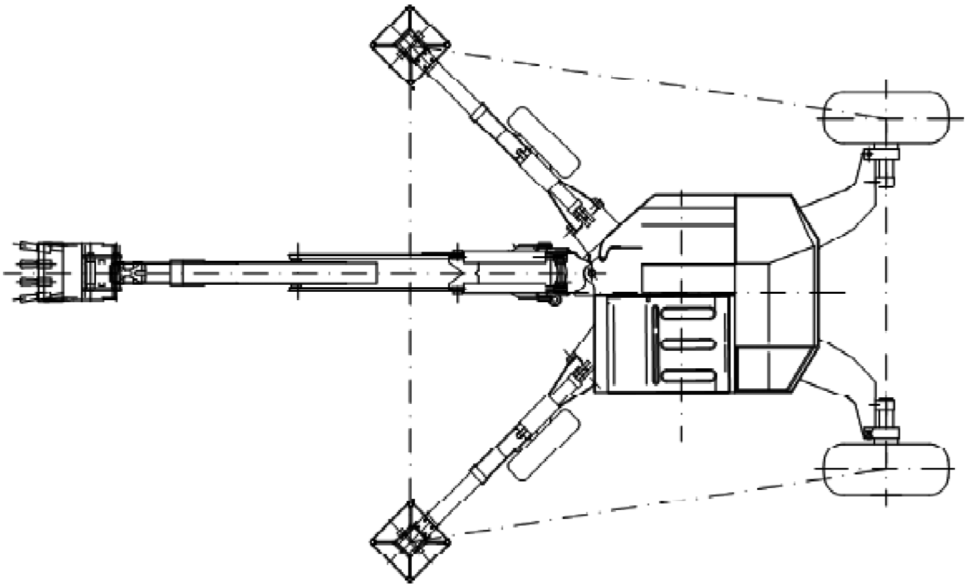
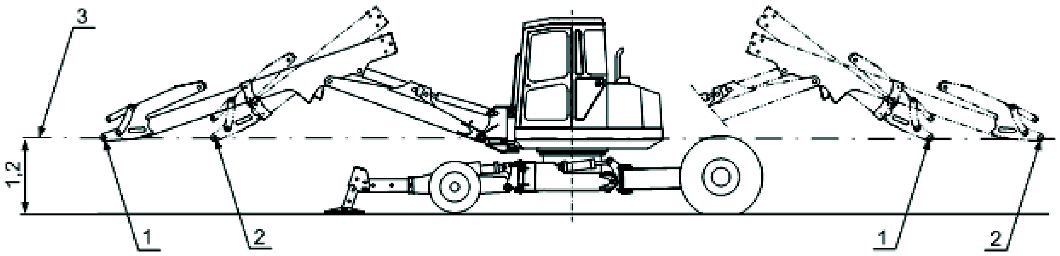


FIG. 1 TIPPING LINES OF WALKING EXCAVATORS

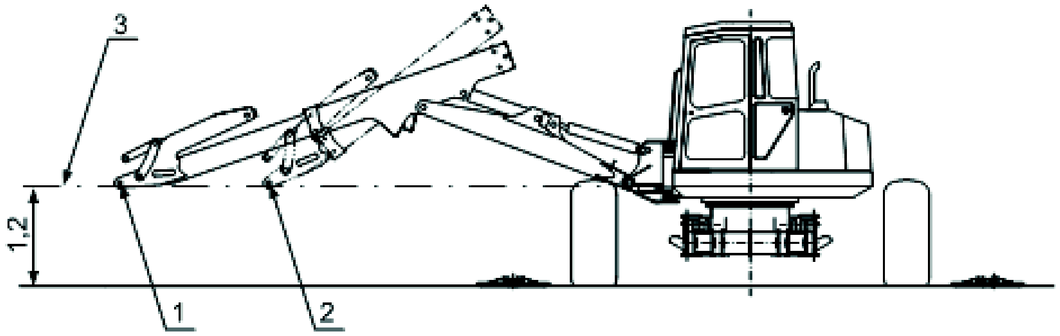
Dimensions in metres.



Key	
1	fully extended
2	fully retracted
3	measuring line

FIG. 2 MEASUREMENT OF RATED TIPPING LOAD TO FRONT/REAR

Dimensions in metres.



Key	
1	fully extended
2	fully retracted
3	measuring line

FIG. 3 MEASUREMENT OF RATED TIPPING LOAD TO THE SIDE

4.6.5 *Retrieval and Towing*

IS 17055 (Part 1) : 2018, **4.15**, shall apply, except for IS 17055 (Part 1) : 2018, **4.15.2** and **4.15.5**.

5 INFORMATION FOR USE

IS 17055 (Part 1) : 2018, **6.2**, shall apply with the following additions:

a) A description of the excavator configuration required if intended to be used for object handling;
b) A description of excavator stability in different applications;
c) A description of special precautions for walking excavators;
d) Instructions for operation of the load safety devices, if fitted;
e) Where applicable, a table of the rated lift capacity in object handling; and
f) Instructions for the selection and use of operator protective guards, for example, top guard, front guard (*see* **4.2.1.1**), appropriate for the application.

ANNEX A

(*Normative*)

REQUIREMENTS FOR EXCAVATOR SWING BRAKES

A-1 GENERAL

Annex A specifies minimum performance criteria and test methods for the swing service brake, swing parking brake and swing lock of hydraulic excavators.

A-1.1 Minimum Performance

A-1.1.1 *Swing Movement*

A-1.1.1.1 *Test-swing revolution speed*

The test-swing revolution speed shall be the working swing revolution speed.

A-1.1.1.1.1 *Deceleration swing angle,* β_B

The deceleration swing angle, β_B, shall be less than the higher of the following values:

$$\beta_B = 90°$$

or,

$$\beta_B = \frac{n^2 \cdot 360}{2 \cdot n'_B} + \beta_{B0}$$

Where,

n is the test-swing revolution speed (min^{-1});

n'_B = 250 (min^{-2});

β_{B0} = 40°.

A-1.2 Swing Service Brake

The swing service brake shall be capable of decelerating the upper structure to a complete stop from the test swing revolution speed as specified in **A-1.1.1**. A disconnection of the swing service brake shall not be possible. (*see* Fig. **A-1**).

During no less than 10 tests the deceleration swing angle shall not exceed by more than 20 percent the deceleration swing angle β_B (*see* **A-1.1.1.1.1**). These tests shall be made at a sequence rate as rapid as the swing acceleration and deceleration will allow.

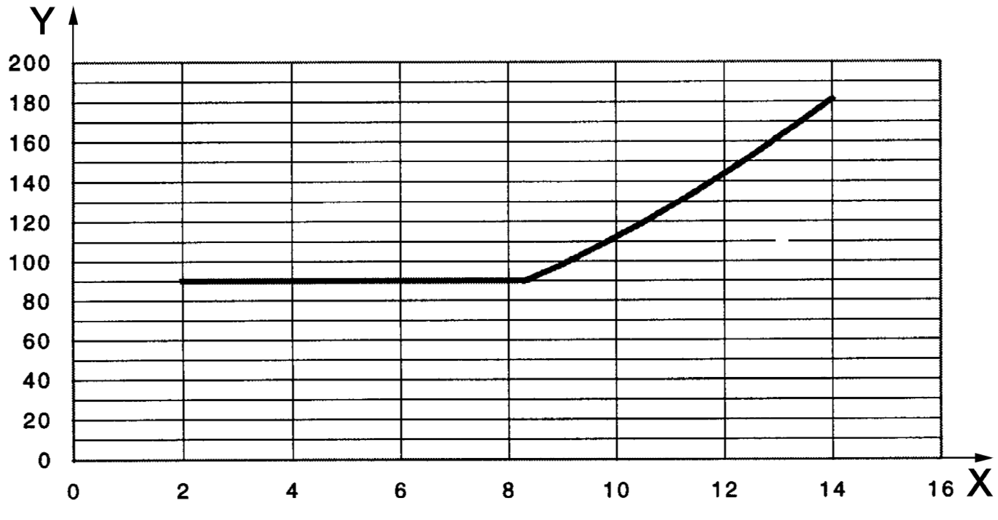
A-1.3 Swing Parking Brake

The swing parking brake shall be capable of holding the upper structure for 30 min in the maximum slope and in the most unfavourable position of the upper structure, as specified by the manufacturer. The working equipment shall be extended to maximum radii with the empty bucket in rollout position.

The swing parking brake shall apply automatically in case of engine stop or shall be capable of being manually applied, with and without the engine running.

The swing parking brake shall remain effective when the source of energy fails.

The swing parking brake on excavators with an operating mass ≥6 000 kg shall be fully mechanical, for example, spring friction brake. On excavators with



Key	
X	upperstructure revolutions, r/min^{-1}
Y	deceleration swing angle, °

FIG. A-1 SWING SERVICE BRAKE

an operating mass < 6 000 kg the swing parking brake may be a hydraulic lock valve applied directly to the swing motor and if so a separate swing lock according to **A-1.4** shall be provided.

NOTES

1 The above requirement of a fully mechanical swing parking brake is not intended to prevent future development of other types of technology providing equivalent safety.

2 A swing parking brake could perform as an emergency brake in case of hose failure.

Excavators with an operating mass < 1 000 kg do not require a swing parking brake.

A-1.4 Swing Lock

The swing lock shall be capable of withstanding without permanent deformation the maximum swing motor torque.

A swing lock is not required if its function is provided by the swing parking brake.

A-2 TEST CONDITIONS

The tests shall be made with the standard equipment specified by the manufacturer.

Outriggers and blade, if present, shall be placed on the ground in their working position as specified by the manufacturer.

All fluid system shall be filled as specified by the manufacturer. The fuel tank shall be at least half full. The swing system pressures shall be adjusted and function as specified by the manufacturer.

The test for the swing service brake to define the test swing revolution speed according to **A-1.1.1** and deceleration swing angle according to **A-1.1.1.1.1** shall be made with the working equipment extended to maximum radii with the empty bucket in rollout position.

The measurement starts with the actuation of the braking at test swing revolution speed.

For the test of the service swing brake and the swing lock, the machine shall be positioned on a flat surface with a maximum gradient slope of ± 1 percent.

A-3 TEST REPORT

The test report shall contain the following information:

a) Machine manufacturer;
b) Model and serial-number;
c) Machine specification; and
d) Result of test.

ANNEX B

(*Informative*)

ILLUSTRATIONS

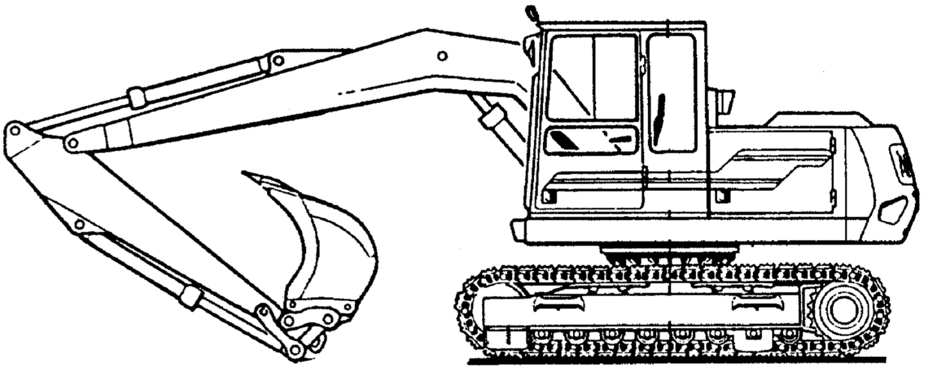


FIG. B-1 CRAWLER EXCAVATOR

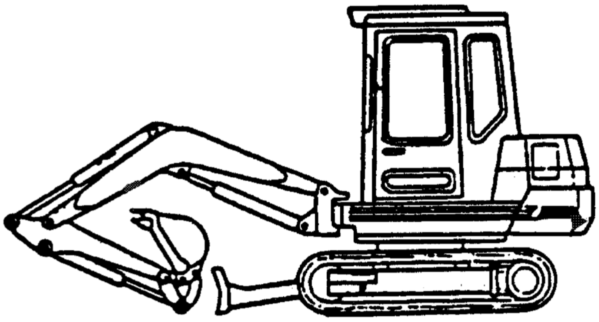


FIG. B-2 COMPACT CRAWLER EXCAVATOR

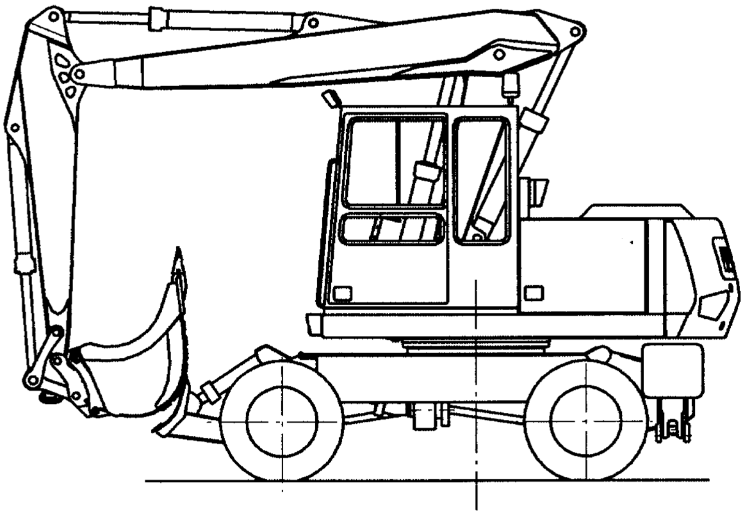


FIG. B-3 WHEELED EXCAVATOR

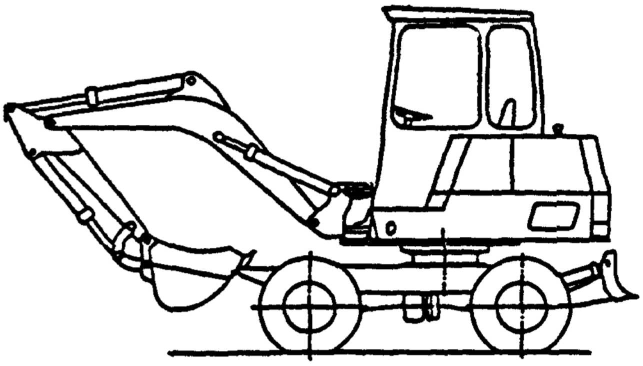


Fig. B-4 Compact Wheeled Excavator

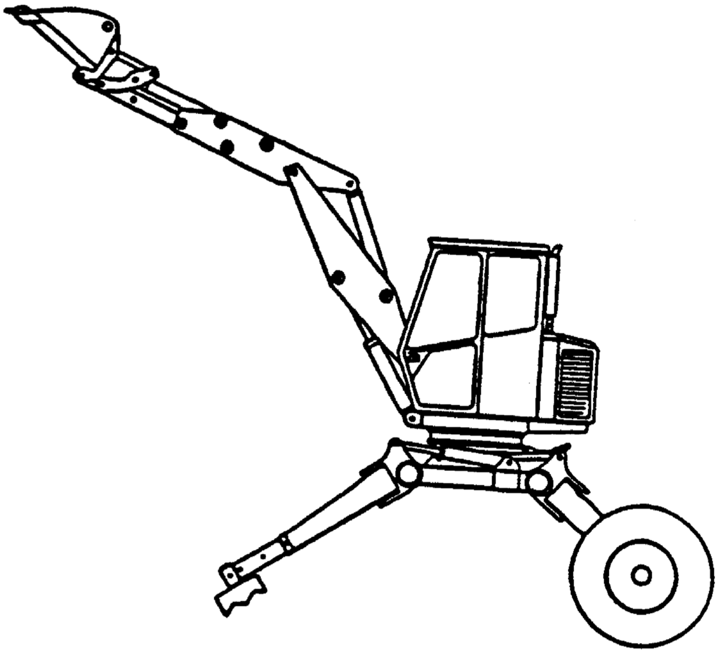


Fig. B-5 Walking Excavator

Bureau of Indian Standards

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